REMARKS

Claims 2-26 and 51-55 are pending in the present application. Claims 27-31 and 48-50 have been cancelled. New claim 55 has been added. Claims 2-9, 12-13, 15-19, 24-26 have been amended. With this amendment claims 2-26 and 51-55 are presented for Examination, of which claim 55 is an independent claim and the remaining claims further limit and depend from claim 55. Reconsideration of the present application is respectfully requested in light of the foregoing amendments and following remarks.

I. Rejections Under 35 U.S.C. § 112

Claims 2-31 and 48-54 have been rejected under 35 USC 112, second paragraph, as being indefinite for failing to point out and distinctly claim the subject matter which Applicant regards as the invention. In particular, the Examiner had taken issues with the manner in which the word "port," and the phrase "non-imaging optical concentrator" have been recited in the claims. Furthermore, the Examiner has found the description of the phrase "sections parallel to the plane of the corner" to be unclear. Additionally, the Examiner is unclear regarding the use of the terms "planar reflective surfaces," "sections of parabolas," and how a corner is formed in parabolic sections.

Applicant has amended claims 2-9, 12-13, 15-19, 24-26, as set forth above, to clarify the language of the claimed subject matter and provide further definitions where necessary to remove ambiguities and thus render the claimed subject matter more clearly and more distinctly. Applicant respectfully submits that the claims as amended overcome the Examiner's section 112 rejections. Furthermore, considering that claims 27-31 and 48-50 have been cancelled, the Examiner's section 112 rejection of these claims is now moot.

In addition to the amendments made to overcome the Examiner's section 112 rejections, claims 2, 8, 12, 17, and 24-26 have been amended to further limit and depend from new claim 55. It is noted that as initially filed, claims 2, 8, 12, 17, and 24-

26 added further limitations to and depended from originally filed claim 1. In the Office Action mailed February 2, 2000, claims 2-26 and 51-54 were objected to and found allowable if rewritten in independent from to incorporate the limitations of their base claim (originally filed claim 1). In response to the Office Action of February 2, 2000, claims 2, 4, 8, 12, 17, 25 and 26 were amended to incorporate the limitations of the then rejected base claim 1, as the Examiner has found the claims allowable if they were rewritten in independent form. In light of these previous actions, and in light of the reopening of the prosecution of this application, Applicant has amended claims 2, 8, 12, 17, and 24-26 so that they now depend from new claim 55.

II. Rejections Under 35 U.S.C. § 102

The Examiner has rejected claims 2-31 and 48-54 under 35 USC 102(b) as allegedly being anticipated by U.S. Patent 4,898,450 to Jannson et al. (Jannson). In light of the amendments set forth above, Applicant respectfully submits that Jannson does not teach all the elements of new independent claim 55, for reasons set forth below. Specifically, these elements are clearly set out in claim 55, which is shown below:

55. An apparatus for efficiently deflecting light from an optical fiber around a bend, comprising:

a non-imaging optical waveguide, said waveguide being bound by and having a first port and a second port, said non-imaging waveguide adapted to efficiently direct all the light entering through said first port around said bend;

said first port receiving light having divergence angles of less than 90 degrees as measured relative the central axis of said optical fiber, said central axis of said optical fiber being perpendicular to said first port;

said second port emitting light having divergence angles as large as 90 degrees relative to the central axis of said second port, said central axis of said second port being perpendicular to said second port.

The Jannson Reference

The Jannson invention is directed towards a fiber optic connector. For example, the Jannson abstract recites starting with "there is disclosed an expanded beam fiber to fiber connector...." The abstract recites further that "the system consists of two identical connector parts." Additionally, the abstract also recites that "...a lens may be located...." at the connection between the two connectors. The Jannson patent is directed towards a fiber optic beam to beam connector. For example, see col. 3 lines 8-14, where the Jannson patent states that "the non-imaging connector which is the subject matter of the present invention has a higher tolerance to angular misalignment than prior art systems based on imaging optics." Also, see col. 7, lines 14-16, again referring to an example of the connector of the present invention. The Jannson invention deals with developing the contours of the side walls and front and exit surfaces for connectors, which are two identical parts (see col. 3, lines 55-56). The Jannson patent is related to methods for having back-to-back connectors for connecting poorly aligned optical fibers that have a higher tolerance to angular misalignment than prior art systems based on imaging optics.

The Cited Art Distinguished

The Jannson reference does not teach non-imaging devices for bending light from fiber optic cables around a bend in an efficient and compact manner. In stark contrast, the presently claimed invention teaches a suite of non-imaging devices for the efficient and compact turning of light around a corner from one optical fiber to another.

Turning now to the portions of the Jannson reference relied upon by the Examiner as a basis for his 35 U.S.C. 102(b) rejections, Applicant respectfully submits that the Jannson reference does not teach efficient non-imaging optical corner turning. The Examiner has relied on the language describing the arrangement of Fig. 11 of the Jannson reference. The Jannson patent clearly calls the device of Fig. 11 a four port

directional coupler (see col. 7, lines 29-30). The entire disclosure that could be presumed to relate to the corner turning teachings is contained in one sentence where the Jannson patent recites "input beams can be split into output beams by means of a suitable half-mirror..." (see col. 7, lines 31-32). Nowhere else does the Jannson patent provide any teachings related to any device other than a "connector" which is the subject matter of the Jannson patent. Applicant respectfully submits that the phrase "suitable half-mirror" is unclear and undefined; what is suitable? and how is a half-mirror an optically efficient non-imaging device?

The mere presence of the sentence citing a "a suitable mirror" is a testament to the lack of teachings related to such a device. First, a mirror is an imaging device, and hence not a non-imaging device. Second, a statement directed to a suitable mirror begs the question of "what is a suitable mirror that would work efficiently and in a compact manner?" The Jannson patent does not teach what a suitable mirror is, and/or how one would go about making such a device. Furthermore, a half-mirror besides being an imaging device, is also inherently non-efficient. A half mirror is inefficient because it transmits half and reflects half of the energy that is incident upon it. By reflecting half the incident energy, a half-mirror loses ½ of the incident energy and thus is grossly inefficient. The device shown in Fig. 11 of the Jannson reference, reflects light via an **imaging-type half-mirror** around a corner in an imaging manner, **not in a non-imaging manner.** The Jannson device deflects ½ of its incident light, which is an inefficient redirection of optical energy, **not an efficient** redirection of optical energy.

However, the presently claimed invention is directed towards a non-imaging devices for the efficient and compact turning of light around a bend. Besides clearly distinguishing the present claimed invention (i.e., an efficient non-imaging optical corner turner) from the cited art (i.e., an optical connector) as set forth above, the Applicant presents two additional arguments for interpreting the teachings of Jannson and further distinguishing the claimed invention from this cited art. These interpretations are

that: (1) the cited art device is not optically efficient, and (2) the cited art device uses imaging devices, and hence is not a purely non-imaging device.

Turning to the first argument, Applicant submits that a visual inspection of Fig. 1 of the Jannson reference shows that upon exit from the collimator, light rays may exit with a divergence angle of θ_2. Light rays exiting the collimator at any θ_2 greater than zero have the possibility of missing their target surface, which could be a mirror image of Fig. 1, for example as shown in Fig. 4 (of Jannson). Since light rays could miss the target surface, the arrangement of Fig. 1 (of Jannson) is not optically efficient. Jannson's lack of optical efficiency clearly distinguishes the present claimed invention from the Jannson reference.

Turning now to the second argument, Applicant submits that the Jannson device uses imaging elements to address the potential inherent inefficiencies of its connector. The arrangement for a connector shown in Fig. 2 of Jannson shows a "lens-type front surface" to increase the overall optical efficiency of its system. The lens is used to focus the light rays onto the receiving surface. Here, Jannson is using imaging optical devices such as a lens to increase the efficiency of its in-line beam-to-beam connector. However, the present claimed invention, which is based on non-imaging optics, achieves efficient corner turning without resorting to the use of lens-type imaging devices. The absence of a imaging devices (e.g. a lens) in the present claimed invention further distinguishes it from the Jannson reference.

In conclusion, Applicant respectfully submits that the Jannson reference does not anticipate new claim 55. Furthermore, considering that claims 2-26 include all of the features of independent claim 55, from which they depend, these claims are patentable to the same extent that new independent claim 55 is patentable.

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached page is captioned "Version with Markings to Show Changes Made."

CONCLUSION

In view of the foregoing, Applicant believes all claims now pending in this Application are in condition for allowance. The issuance of a formal Notice of Allowance at an early date is respectfully requested.

If the Examiner believes a telephone conference would expedite prosecution of this application, please telephone the undersigned at .

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the claims:

Claims 27-31 and 48-50 have been cancelled.

Claims 2-9, 12-13, 15-19, 24-26 have been amended as follows:

2. (Twice Amended) [An apparatus for efficiently deflecting light from an optical fiber around a corner, comprising:

a first port adapted to be coupled to said optical fiber and to receive light with divergence angles of less than 90 degrees from the axis of said optical fiber;

a non-imaging optical waveguide, connected to said first port, and adapted to direct light around said corner;

a second port connected to said non-imaging optical waveguide; and]

The apparatus of claim 55 further comprising

a non-imaging optical concentrator, for delivering a beam of light emitted from said optical fiber having half-angle divergence of 90 degrees, [connected] located between said optical fiber and said first port.

3. (Amended) The apparatus of claim 2 further comprising:

a second non-imaging optical concentrator, its high-divergence side [connected to] coincident with said second port.

4. (Twice Amended) [An apparatus for efficiently deflecting light from an optical fiber around a corner, comprising:

a first port adapted to be coupled to said optical fiber and to receive light with divergence angles of less than 90 degrees from the axis of said optical fiber;

a non-imaging optical waveguide, connected to said first port, and adapted to direct light around said corner;

a second port connected to said non-imaging optical waveguide;]

The apparatus of claim 3,

wherein said second port is adapted to direct light from said optical fiber to a patient, and further comprising:

a second non-imaging optical waveguide having a third port and a fourth port, said second non-imaging waveguide adapted to efficiently direct all the light entering through said fourth port around a second bend;

said fourth port receiving light from the patient,

said third port directing the light received from the patient through said fourth port to a second optical fiber;

a third non-imaging optical concentrator, its low-divergence side coincident with said fourth port; and

a fourth non-imaging optical concentrator, for delivering a beam of light to said second optical fiber, located between said second optical fiber and said third port.

[a third port adapted to be coupled to a second optical fiber and direct light to said second optical fiber with divergence angles of less than 90 degrees from the axis of said second optical fiber;

a second non-imaging optical waveguide, connected to said third port, and adapted to direct light around a corner; and

a fourth port connected to said second non-imaging optical waveguide and configured to receive reflected light from said patient.]

5. (Amended) The apparatus of claim 2 wherein said non-imaging optical waveguide comprises a curved reflective segment [connected] located between said first port and said second port.

6. (Twice Amended) The apparatus of claim 5 wherein, in any section parallel to the plane of said [corner] bend, said curved reflective [section]

segment appears as an arc of a circle, wherein the plane of the bend is the plane through which the maximum angle of bend is exposed.

7. (Amended) The apparatus of claim 5 wherein said curved reflective segment is an inner curve, further comprising a second curved reflective segment as an outer curve, [which is connected] located between said first port and said second port.

8. (Four Times Amended) [An apparatus for efficiently deflecting light from an optical fiber around a corner, comprising;

a first port adapted to be coupled to said optical fiber and to receive light with divergence angles of less than 90 degrees from the axis of said optical fiber;

a non-imaging optical waveguide, connected to said first port, and adapted to direct light around said corner;

a second port connected to said non-imaging optical waveguide;]

The apparatus of claim 55,

wherein every section parallel to the plane of said [corner] bend is geometrically identical, wherein the plane of the bend is the plane through which the maximum angle of bend is exposed, and upper and lower surfaces of said non-imaging optical waveguide are planar reflective surfaces, wherein said upper and lower surfaces are parallel to said plane and bound said waveguide.

9. (Amended) The apparatus of claim 6 wherein said arc has a radius of the width of said first port, and a center at an end of said first port at an inside of said turn around said [corner] bend.

12. (Twice Amended) [An apparatus for efficiently deflecting light from an optical fiber around a corner, comprising:

a first port adapted to be coupled to said optical fiber and to receive light with divergence angles of less than 90 degrees from the axis of said optical fiber;

a non-imaging optical waveguide , connected to said first port, and adapted to direct light around said corner;

a second port connected to said non-imaging optical waveguide;]

The apparatus of claim 55, further comprising

a non-imaging optical concentrator for delivering a beam of light having half-angle divergence of 90 degrees, [connected] located between said optical fiber and said first port; and

wherein said non-imaging optical waveguide comprises a first curved reflective segment extending along an outside of a turn around of said [corner] bend, and a second curved reflective segment extending around an inside of said turn around said [corner] bend.

13. (Twice Amended) The apparatus of claim 12 wherein, in any section parallel to the plane of said [corner] bend, said first curved reflective segment appears as a section of a first ellipse and said second curved reflective segment appears as a section of a second ellipse, wherein the plane of the bend is the plane through which the maximum angle of bend is exposed.

15. (Twice Amended) The apparatus of claim 14 wherein

every section parallel to the plane of said [corner] bend is geometrically identical, wherein the plane of the bend is the plane through which the maximum angle of the bend is exposed, and

upper and lower surfaces of said non-imaging optical waveguide are planar reflective surfaces, wherein said upper and lower surfaces are parallel to said plane and bound said waveguide.

16. (Twice Amended) The apparatus of claim 14 wherein:

said non-imaging optical concentrator is of the 3D type, and

in every section parallel to the plane of said [corner] bend, said first curved reflective segment is of such size as to contact the outer edge of said first port and said second curved reflective surface is of such size as to contact the inner edge of said first port, wherein the plane of the bend is the plane through which the maximum angle of the bend is exposed.

17. (Twice Amended) [An apparatus for efficiently deflecting light from an optical fiber around a corner, comprising:

a first port adapted to be coupled to said optical fiber and to receive light with divergence angles of less than 90 degrees from the axis of said optical fiber;

a non-imaging optical waveguide, connected to said first port, and adapted to direct light around said corner;

a second port connected to said non-imaging optical waveguide;]

The apparatus of claim 55,

wherein said non-imaging optical waveguide comprises:

a first reflective segment extending along an inside of a turn around said [corner] bend from said first port to said second port, such that in any section parallel to the plane of said [corner] bend, said first reflective segment appears as a straight line; and

a second reflective segment extending along an outside of said turn around said [corner] bend from said first port to said second port, such that in any section parallel to the plane of said [corner] bend, said second reflective segment appears as a curve comprising

a first parabolic segment extending from said first port,

an elliptical segment extending from said first parabolic segment, and

a second parabolic segment extending from said elliptical segment to said second port, wherein the plane of the bend is the plane through which the maximum angle of the bend is exposed.

18. (Twice Amended) The apparatus of claim 17 wherein:

every section parallel to the plane of said [corner] bend is geometrically identical, and

upper and lower surfaces of said non-imaging optical waveguide are planar reflective surfaces, wherein said upper and lower surfaces are parallel to said plane and bound said waveguide.

19. (Twice Amended) The apparatus of claim 17 wherein:

said first port is circular in cross section, and

in every section parallel to the plane of said [corner] bend, said first curved reflective segment is of such size as to contact the outer edge of said first port and said second curved reflective surface is of such size as to contact the inner edge of said first port.

24. (Three Times Amended) [An apparatus for efficiently deflecting light from an optical fiber around a corner, comprising:

a first port adapted to be coupled to said optical fiber and to receive light from the axis of said optical fiber;

a non-imaging optical waveguide, connected to said first port, and adapted to direct light around said corner;

a second port connected to said non-imaging optical waveguide;

wherein said non-imaging optical waveguide comprises:

a first reflective segment extending along an inside of a turn around said corner from said first port to said second port, such that in any section parallel to

the plane of said corner, said first reflective segment appears as a straight line; and

a second reflective segment extending along an outside of said turn around said corner from said first port to said second port, such that in any section parallel to the plane of said corner, said second reflective segment appears as a curve comprising

a first parabolic segment extending from said first port,

an elliptical segment extending from said first parabolic segment,

a second parabolic segment extending from said elliptical segment to said second port,]

The apparatus of claim 17, wherein said second port is at an angle of less than ninety degrees from said first port, and further comprising:

a third port around a second [corner] bend from said second port;

a third reflective segment extending along an inside of a turn around said second [corner] bend from said second port to said third port, such that in any section parallel to the plane of said [corner] bend, said third reflective segment appears as a straight line;

a fourth reflective segment extending along an outside of said turn around said second [corner] bend from said second port to said third port, such that in any section parallel to the plane of said [corner] bend, said fourth reflective segment appears as a curve comprising:

a third parabolic segment extending from said second port,

a second elliptical segment extending from said third parabolic segment, and

a fourth parabolic segment extending from said second elliptical segment to said third port.

25. (Twice Amended) [An apparatus for efficiently deflecting light from an optical fiber around a corner, comprising:

a first port adapted to be coupled to said optical fiber and to receive light with divergence angles of less than 90 degrees from the axis of said optical fiber;

a non-imaging optical waveguide, connected to said first port, and adapted to direct light around said corner;

a second port connected to said non-imaging optical waveguide;]

The apparatus of claim 55,

wherein said first and second ports are rectangular.

26. (Twice Amended) [An apparatus for efficiently deflecting light from an optical fiber around a corner, comprising:

a first port adapted to be coupled to said optical fiber and to receive light with divergence angles of less than 90 degrees from the axis of said optical fiber;

a non-imaging optical waveguide, connected to said first port, and adapted to direct light around said corner;

a second port connected to said non-imaging optical waveguide; and]

The apparatus of claim 55,

wherein said first and second ports are circular.

Claim 55 has been added as follows:

55. An apparatus for efficiently deflecting light from an optical fiber around a bend, comprising:

a non-imaging optical waveguide, said waveguide being bound by and having a first port and a second port, said non-imaging waveguide adapted to efficiently direct all the light entering through said first port around said bend;

said first port receiving light having divergence angles of less than 90 degrees as measured relative the central axis of said optical fiber, said central axis of said optical fiber being perpendicular to said first port;

said second port emitting light having divergence angles as large as 90 degrees relative to the central axis of said second port, said central axis of said second port being perpendicular to said second port.